AIR FORCE

QUALIFICATION TRAINING PACKAGE

(AFQTP)

for

HVAC/REFRIGERATION

(3E1X1)

MODULE 23

WARM AIR HEATING

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MODULE 23

WARM AIR HEATING

Career Field Education and Training Plan (CFETP) references from 1 Apr 97 version.

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AIR FORCE QUALIFICATION TRAINING PACKAGES
for
HVAC/REFRIGERATION
(3E1X1)

INTRODUCTION

Before starting this AFQTP, refer to and read the "Trainee/Trainer Guide" located on the AFCESA Web site **http://www.afcesa.af.mil/**

AFQTPs are mandatory and must be completed to fulfill task knowledge requirements on core and diamond tasks for upgrade training. ***It is important for the trainer and trainee to understand*** that an AFQTP ***does not*** replace hands-on training, nor will completion of an AFQTP meet the requirement for core task certification. AFQTPs will be used in conjunction with applicable technical references and hands-on training.

AFQTPs and Certification and Testing (CerTest) must be used as minimum upgrade requirements for Diamond tasks.

MANDATORY minimum upgrade requirements:

Core task:
AFQTP completion
Hands-on certification

Diamond task:
AFQTP completion
CerTest completion (80% minimum to pass)

Note: *Trainees will receive hands-on certification training for Diamond Tasks when equipment becomes available either at home station or at a TDY location*.

Put this package to use. Subject matter experts, under the direction and guidance of HQ AFCESA/CEOT, revised this AFQTP. If you have any recommendations for improving this document, please contact the HVAC/R Career Field Manager at the address below.

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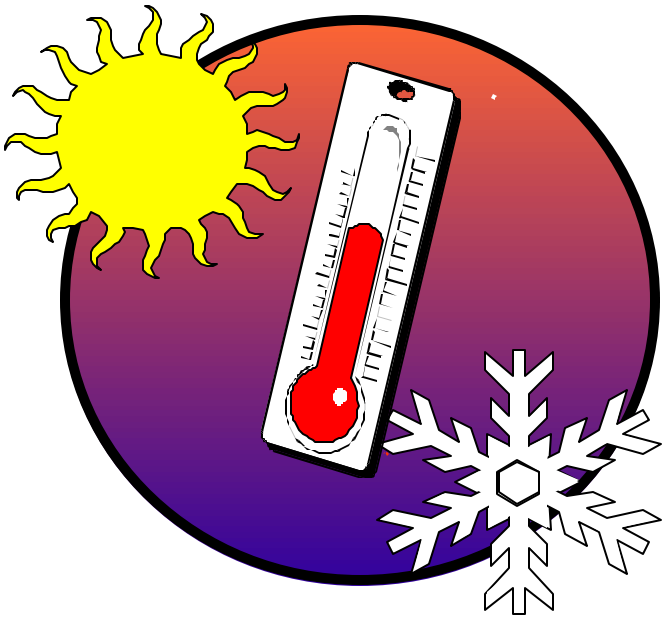
Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.



REPAIR

MODULE 23 **AFQTP UNIT 5**

TROUBLESHOOT (23.5.1.)

CORRECT MALFUNCTIONS (23.5.2.)

TROUBLESHOOT

CORRECT MALFUNCTIONS

Task Training Guide

STS Reference Number/Title:	23.5.1. Troubleshoot 23.5.2. Correct Malfunctions
Training References:	• TR: ASHRAE Handbook, 1988 Equipment and 1988 HVAC Systems and Applications • Appendix A of the Modine Manufacturing Company bulletin number 75-551, November 1982, titled "Service Diagnosis."
Prerequisites:	• Possess as a minimum a, 3E131 AFSC.
Equipment/Tools Required:	• Personnel Protective Equipment. • Standard HVAC/R Tool Bag.
Learning Objective:	• Trainee should know the steps to safely troubleshoot warm air heating systems.
Samples of Behavior:	• Trainee should be able to troubleshoot warm air heating systems.
Notes:	
Any safety violation is an automatic failure.	

TROUBLESHOOT

CORRECT MALFUNCTIONS

Background: A troubleshooter is defined as one who locates and eliminates sources of troubles. Troubleshooting then is locating and eliminating sources of trouble(s). When we as HVAC/R mechanics eliminate the source(s) of trouble, we must locate the original source of trouble. For example, when a motor overload trips, simply pushing the reset button is not considered locating the source or eliminating the source of the trouble. Something caused the motor current to rise and trip, or open, the protective device. The most important thing for you to remember is that you must ensure you have eliminated the source of the problem, not just a symptom of the problem. This is commonly known as finding the root of the problem.

To perform these tasks, follow these steps:

Step 1: Lubrication. Most direct-drive blower motors do not require oiling, but check the manufacturer's instructions just in case. When you find a blower turning slower than required chances are it is suffering from lack of lubrication or defective bearings (bearings discussed later). This could be caused by the blower shaft or motor bearings having a lack of lubrication. The shaft should turn freely without stiffness. If stiffness is indicated, lubricate the bearings. If lubrication does not solve the problem then you must replace the bearings or purchase a new motor.

Step 2: Bearings. Some belt-driven blowers have self-aligning bearings. Others have bearings that are held in place by bolts to stabilize the bearings to the blower housing. If the bearings are binding, loosen the bolts and let the bearings come into alignment before you tighten them. The thrust collars are locked to the shaft on the lock side of the bearings. A leather washer is located between this and the end of the bearings. The collars keep the shaft from sliding out of the bearings and when properly adjusted, prevent endplay. If you hear a thumping noise in the blower, it is the result of too much endplay. Adjust the collars and the noise should disappear. Make sure you adjust the collars as close to the sides of the bearings as possible without binding against the bearing.

Defective bearings will overload the motor and will cause the blower to turn slower than required. Therefore, the airflow will be reduced, affecting equipment operation. To check for defective bearings, remove the fan belt and grasp the blower shaft in the hand. Move the shaft from side to side. If sideways movement is detected, replace the bearings. If no side-to-side movement is detected then turn the motor by hand, it should turn freely. If stiffness is indicated lubricate the bearing. If lubrication doesn't rectify the problem replace the bearings. Be sure to check the blower shaft wear for scoring. If scoring is indicated replace the shaft also.

Step 3: Burner. The purpose of the main burner is to provide a place for the mixing of fuel and air and a place for the burning of the mixture. There are several conditions that effect the operation of a burner, such as distorted carryover wing slots, dirty burner, primary air adjustments, poor flame travel to the burner, and poor flame distribution. If the slots in the carryover wing on a gas burner become distorted, the ignition flame will not travel properly and flashback (gas burning at the orifice) will occur. The solution to this problem is to repair the slots. This is accomplished by restoring them to their original condition. If repair is not practical then the burner should be replaced. Dirty burners are also a cause of flashback and possible delayed ignition. To correct this problem, remove the burners and clean both the inside and outside. The burner ports must be cleaned with extreme care to prevent damage. Air pressure may be used to blow out the inside of the burner to remove any collected dirt or soot. Removing the burners from the furnace will ease the cleaning.

Primary air is yet another problem that causes burners to not operate properly. The amount of primary air drawn into the burner determines the type of flame present. When primary air is restricted the flame will be yellow, indicating poor combustion. When too much primary air is let in, the result is a hard, blowing flame, also indicating poor combustion. The ideal flame will be neither hard and blowing nor contain yellow tinges. To adjust a burner for a proper flame, first close the primary air shutter to obtain a yellow flame. Secondly, open the primary air shutter adjustment until the yellow flame has disappeared. Thirdly, open the shutter adjustment about one-eighth more (one-eighth of the total shutter adjustment).

Step 4: Thermostat. Thermostats are temperature sensitive devices used to control equipment response to the demands of the space in which they are located. Because of the many types and manufacturers' designs, it would be nearly impossible to cover the adjustments of all thermostats. An important thing to remember is that if a thermostat uses a mercury tube instead of contact points you must carefully level the thermostat. You can use a plumb bob or spirit level to ensure the thermostat is level. The location of the thermostat can affect the operation of the heating system. Before you make any adjustments, first ensure the thermostat is not exposed to heat from lamps, sunlight, fireplaces, coffee pots, etc., or to cold from windows, doors, drafts, etc. The thermostat should be installed where it will register, as closely as possible, the average ambient temperature to be controlled. Try to locate T-Stats on interior walls away from a door and not directly under a supply air vent. It should be mounted about 4 or 5 feet above the floor.

To check a thermostat turn it below room temperature and place a reliable thermometer as close as possible to the bimetal element, without allowing the thermometer to touch the element. Allow the thermometer to remain there for 10 minutes. Next turn the thermostat temperature up. The contacts should "make" (close) at no more than 2 degrees F (1.11 degrees C) above the temperature indicated by the thermometer. If contacts fail to close then a calibration of the thermostat is required. If more than 10 degrees off (5.56 degrees C), replace the thermostat. There are several means of calibrating a thermostat.

Therefore, the manufacturer's specifications should be consulted. In most cases, an inoperative thermostat can be checked by checking the voltage from the red terminal to the heating terminal. If the contacts are closed, no voltage will be indicated. If the contacts are open, a voltage will be indicated.

Step 5: Limit Control. The limit control is a safety device, wired in series to the main gas valve, used to interrupt electrical power to the main gas valve when an overheated condition occurs. It is a bimetal temperature-sensing switch with normally closed contacts that open at approximately 200 degrees F (93 degrees C). For proper operation of a limit control, insert a thermometer in the re-circulating air stream as close to the sensing element as possible. Reduce the airflow through the furnace and observe the thermometer when the main burner flame goes off. If this temperature is about 200 degrees F (93 degrees C), the limit control is function properly. The trouble will be something else. If the temperature indicated is not quite 200 degrees F (93 degrees C), adjust the control; make only minor adjustments to the limit control. If the temperature is off by as much as 20 degrees F (9.4 degrees C), replace the limit control. When replacing the limit control, ensure that the replacement control has the same length, sensing element.

Step 6: Fan Control. The fan control is used on heating systems to start and stop the fan motor on an increase or decrease in temperature inside the furnace. This control is manufactured in adjustable and non-adjustable types as well as in extended element and bimetal disk types. The fan off temperature is generally set at 5 to 10 degrees F above the desired maximum thermostat setting. This turns the fan off before the air entering the room becomes too cool to heat the room effectively and actually feels like a draft. The fan ON temperature is set at approximately 20 degrees F higher than the fan OFF temperature so that the fan will not start before the temperature of the air leaving the unit is warm enough. For example, if the temperature were 90 degrees F, the fan OFF setting would be from 95 to 100 degrees F and the fan ON setting would be 115 to 120 degrees F. Some manufacturers use electric time delay relays for fan controls on some units. The electric types are preset for a specific time to lapse for the ON and OFF settings.

To check for the proper operation of a fan control, place a thermometer in the unit as close as possible to the sensing element. Start the main burner and observe the thermometer. When the desired temperature is met or the specified time has lapsed, the fan should start. If not, adjust the control if it is of the adjustable type. Then stop the main burner and observe the thermometer. When approximately 100 degrees F is reached, the fan should stop. If it does not stop, adjust the control if it is of the adjustable type. If more than 15 degrees F of adjustment is needed, or the control is not adjustable, replace the switch. Replacement of exact control is important for proper operation.

SAFETY:
NEVER ATTEMPT TO MAKE INTERNAL ADJUSTMENTS ON THESE CONTROLS DUE TO THE DANGER OF OVERHEATING AND PERMANENTLY DAMAGING THE EQUIPMENT, OR POSSIBLE FIRE AND PERSONAL INJURY.

Step 7: Combination Control. Combines the limit control and the fan control. All troubleshooting adjustments and repairs should be conducted as if components were separate.

Step 8: Blower Speed. Centrifugal fan units operate under a wide range of speeds. The exact speed of a specific fan unit depends on the design of the system in which the fan is installed. The technician obtains the proper speed ratio between the blower and the motor. Also, to permit minor speed ratio changes, the motor sheave is usually adjustable.

To fix a problem with improper blower speed you must first contact the manufacturer or have available data on the unit. This should help you achieve maximum output from the unit without damaging the motor, overloading the electrical circuit or going beyond fan curve capabilities of the blower. Always check the speed of the motor and blower with an accurate tachometer under max load conditions.

Increasing or decreasing the blower speed changes the temperature rise through a furnace. When the maximum temperature rise in a furnace is reached, minimum air is flowing. Exceeding this limit may damage the heater. The opposite occurs if the minimum temperature rise is reached through a furnace, the maximum amount of air is flowing. Cold drafts may be experienced if these limits are exceeded. The temperature rise through the furnace is obtained by placing a dry bulb thermometer as close to the furnace's air inlet and outlet. The difference between the two readings is the furnace's temperature rise.

Step 9: Belt Tension. Since a new belt is somewhat shorter than an old stretched belt, you must not force it on the sheaves. To make sure you do not force it, loosen the motor on its base and shift it closer to the blower. Then place the belt on the motor and blower sheaves, readjust the motor, and tighten it to the base. The belt must fit completely in the "V" of both sheaves; otherwise, you will have rapid wear, noise, and slipping. A good method for checking proper tension is to strike the belt with your hand. If the belt is properly adjusted, it will vibrate; a slack belt will feel dead and will not vibrate. Be careful that you tighten belts no more than necessary to prevent slippage. A belt that is too tight can cause an extra load on the motor and damage both the motor and blower bearings. Always run an amp check after installing or adjusting motor or blower belts. On new belts, recheck the belt tension after you operate the motor for 24 to 48 hours.

Step 10: Sheave Alignment. Check the motor and blower sheave alignment each time you replace a belt, adjust sheaves, or loosen the motor on its mount. Some indications that you may have a sheave alignment problem are frequent replacement of belts, new belts getting thrown from sheave, or abnormal wear on sheave flanges. You can check sheave alignment by using a straightedge or a tight line (string). Remember, it is important to ensure proper alignment because improper alignment of sheaves shortens the life of belts and causes excessive wear on the faces of the sheave flanges.

Step 11: Heat Exchanger. The heat exchanger in furnaces acts as the combustion area, the transfer medium, and the flue passages. The heat exchanger is sometimes called the "heart" of the heating system. The most common problems that occur with a heat exchanger are restrictions and cracks or openings in the metal, (Figure 1).

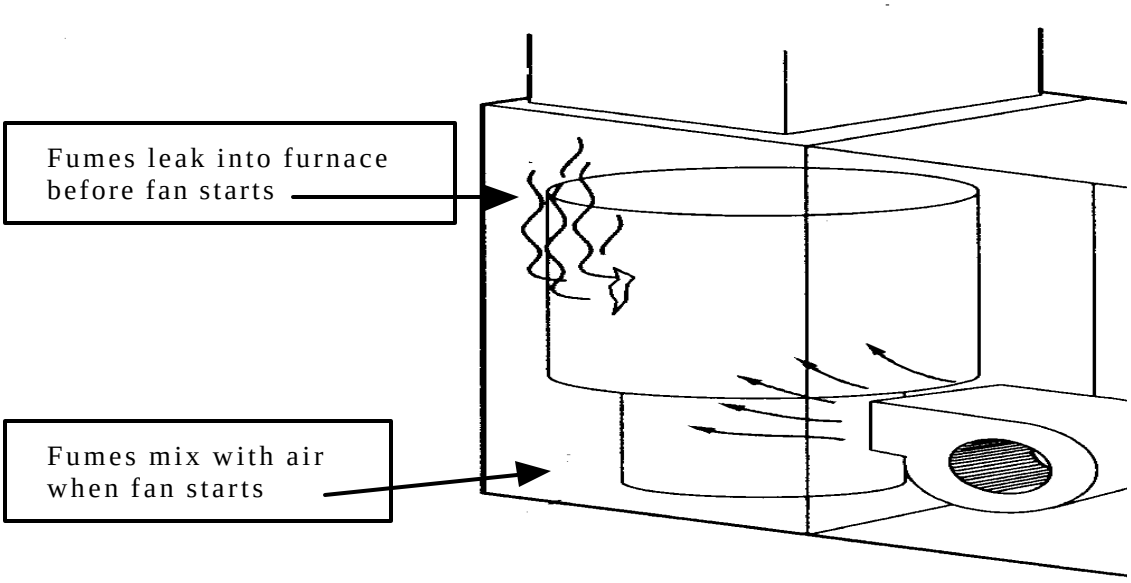


Figure 1, Cracked heat exchanger

NOTE:
Fumes may leak to the air side and be blown into the heated space when the fan starts.

Restrictions in the flue passages of a heat exchanger upset the draft through the furnace and interfere with the combustion process. These restrictions must be removed to restore normal operation. Clean the heat exchangers at least annually. When you clean the heat exchanger, use a wire brush to remove soot and corrosion deposits. Then use a vacuum cleaner to remove any deposits that remain.

NOTE:
Utilize a vacuum cleaner that has been dedicated for this cleanup procedure.

Cracked heat exchangers are hazardous due to possible fire and carbon monoxide poisoning. A cracked heat exchanger allows the re-circulating air and the products of combustion to mix. Small cracks in the exchanger may be hard to find but larger cracks may be tested for with available indoor air quality products (i.e., non-hazardous smoke devices). If you feel you have a cracked exchanger, turn off the unit and place a smoke device in the combustion zone. Place the smoke device first in one section and then in another while the fan is in operation. The smoke will be blown out of the burner opening. A cracked heat exchanger should be replaced, never repaired. A heat exchanger that has cracked once will probably crack again.

Step 12: Blower Assembly. The blower fan requires some attention at least annually. Clean the blower by using a dry rag to remove any dust or accumulation that has formed on the fan blades then vacuum left over accumulation. It only requires a small amount of dust buildup to drastically reduce the air output of the fan. Therefore, dust or lint in the air will clog the blower wheel (Figure 2). The wheel can be cleaned by removing the motor from the housing and using a screwdriver blade to scrape the dirt off the wheel (Figure 3).

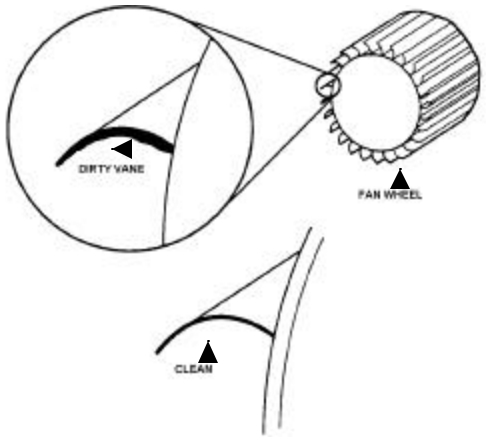


Figure 3, The fan, or blower wheel must be free of dirt.

When cleaning the fan blades, be careful not to move any balancing weights. To move them or to loosen them unbalances the fan and causes damage to the fan bearings in a short period of time. Also, take care not to bend any blades. If the blades become bent, the bearings can be damaged and blower efficiency will be reduced. If you have an out of balance fan the best remedy is to get a manufacturers replacement.

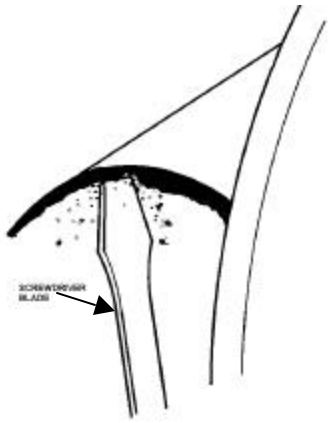


Figure 4, Cleaning the blower wheel.

Step 13: Flame Detector Circuit. The purpose of the flame detector is to determine whether or not a satisfactory flame has been established in the firebox of an oil burner unit. If a satisfactory flame has not been established in approximately 60 seconds, the flame detector

will shut down the oil burner. When determining whether the flame detector is defective, improperly positioned, or dirty, you must start from simple and work to hard. The simple being to see if soot accumulation has formed on the face of the cad cell and clean it. The hard part is determining whether the flame detector leads of the cad cell are shorted. The equipment manufacturer determines the proper application, location, and mounting of flame detector units.

Step 14: Oil Burner Blower Wheel. The purpose of the oil burner blower wheel is to furnish the combustion air to the flame. A binding wheel will reduce or completely stop the combustion air. This binding could be due to a loose setscrew, allowing the blower to get out of alignment, or dirty or worn out bearings. To test for a binding blower wheel, simply rotate the blower by hand. If the blower wheel rubs against any component, the wheel must be adjusted to clear them. If the wheel is hard or stiff to spin, you will have to replace or oil the bearings.

Step 15: Fuel Pump. The purpose of the fuel pump is to supply the fuel oil to the burner with sufficient pressure to atomize the fuel for combustion. There are basically two different pressures used to atomize the fuel: high-pressure 100psig and low-pressure 15psig. A fuel pump is adjustable, within limits, to provide the prescribed pressure for the burner. The method and location of the pressure adjustment will vary with the type and make of pump. Refer to the manufacturer's specifications for the pump in question. Figure 4 shows typical fuel pumps

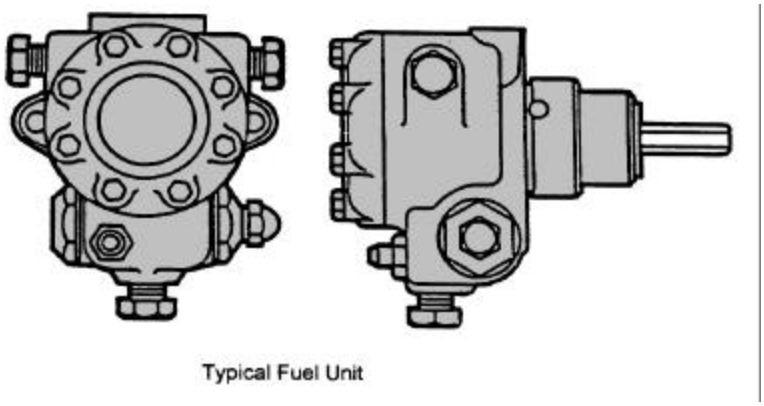
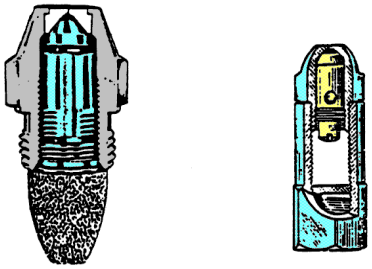


Figure 4, Typical Fuel Pump.

Some problems that occur occasionally with fuel pumps are bearings seizing or a drive belt or coupling breaking. If a bearing seizes it is best to replace the old pump with a new one. Also, remember that fuel pumps are usually provided with a strainer to prevent foreign matter from entering the pump. If strainers become plugged with debris, it will cut down the desired pressure to atomize the fuel. You will need to clean the plugged strainer with gasoline or other suitable solvent.

Step 16: Nozzles. Nozzles are used on oil burners to atomize the fuel to break it up into tiny droplets that can vaporize in a short period of time. The atomizing nozzle performs three

basic and vital functions for an oil burner: atomizing, metering, and patterning. To accomplish proper atomization of the fuel, the nozzle must be designed for the pressure being pumped by the oil pump. If proper atomization is not being obtained and the pump is delivering the prescribed pressure, the trouble is in the nozzle. Figure 5 shows a typical oil nozzle. When replacing a nozzle, consult the orifice manufacturer's specification chart to obtain the correct nozzle for the installation. It is best to follow the recommendations of the equipment manufacturer.



Two Typical Nozzle Assemblies

Figure 5, Two Typical Nozzle Assemblies.

Step 17: Nozzle Filter/Strainer. This is designed to keep dirt and foreign matter from getting into the nozzle and clogging the passages. When the nozzle filter becomes plugged, the flow of fuel is reduced, and under firing of the unit results. A clogged nozzle filter requires that the nozzle be replaced with one having the proper characteristics.

Step 18: Orifices. The purpose of the orifice is to regulate the flow of fuel to the main burner. The orifice is sized according to the type of fuel, the pump or manifold pressure, and the Btu rating of the burner and fuel. Usually, orifices are trouble free and need little attention. However, if you've tried cleaning the orifice and ruined it, the orifice must be replaced. When replacing the orifice be sure to use an exact replacement. Often the furnace and the type of gas used are different. When this happens, the orifice must be sized and replaced for the type of gas used. Check with your local supplier to obtain proper sizing.

Summary. The troubleshooting procedures for all warm air heating equipment are basically the same. Although heated by different mediums such as oil or gas, they have the same purpose, to warm the air. We covered the basic and general troubleshooting procedures required to keep warm air heating equipment operating efficiently and free from trouble.

Review Questions
for
Troubleshoot

Correct Malfunctions

Question	Answer
1. What causes flash back in a burner?	a. Distorted slots b. Excessive Fuel c. Oversized Burner d. Undersized Burner
2. Restricting the primary airflow on a burner will cause a yellow flame, which improves combustion.	a. True b. False
3. An ideal flame is one that doesn't have a yellow tint, but is hard and blowing.	a. True b. False
4. Of the following, which is an ideal place to locate a thermostat?	a. 3 to 4 feet above the ground b. Under a supply vent c. Exterior Wall d. Interior Wall
5. How many degrees F. off calibration must a thermostat be before replacement is recommended?	a. 2 b. 5 c. 8 d. 10
6. A limit control will shut off the main gas valve when the air temperature reaches about ____.	a. 190 degrees F. b. 195 degrees F. c. 93 degrees C. d. 100 degrees C.
7. Some key factors to take into consideration when replacing a limit control are the length and sensing element.	a. True b. False
8. The purpose of the limit control is to ___	a. Prevent overheating. b. Prevent wasting fuel. c. Prevent carbon build up. d. Prevent motor failure
9. What causes cold drafts in a warm air heating system?	a. Increase air flow b. Decrease air flow c. Exceeding minimum temperature rise in furnace. d. Exceeding maximum temperature rise in furnace.

Review Questions
for
Troubleshoot

Correct Malfunctions

Question	Answer
10. What must always be checked after installing or readjusting V-belts?	a. Voltage b. Amperage c. CFM d. RPM
11. Belts being thrown from a sheave are a good indication of what problem?	a. Old belts b. Abnormal wear on sheave c. Misaligned sheaves d. Motor mounts loose
12. The best method of repair to a cracked heat exchanger is to weld it.	a. True b. False
13. How much time will elapse prior to the flame detector shutting down the oil burner if a satisfactory flame is not detected?	a. 20 seconds b. 30 seconds c. 1 minute d. 90 seconds
14. What will cause an oil burner blower wheel to bind up?	a. Dirt b. Worn bearings c. Loose set screw d. All of the above
15. If proper atomization is not being delivered and the pump is supplying the prescribed pressure, where is the problem?	a. Nozzles b. Fuel pump c. Orifices d. Burner
16. How are orifices sized?	a. Type of fuel b. Manifold pressure c. BTU rating d. All of the above
17. Under firing is caused by _____.	a. Plugged nozzle filter b. Worn nozzle c. Increased fuel pressure d. Increase air flow

Review Questions for Troubleshoot

Correct Malfunctions

Instructions: Match the component in column A with its description in column B Items in column B are used only once.

COLUMN A	COLUMN B
(1) _____ Nozzles	**A.** A place for the mixing of fuel and air and to burn the mixture.
(2) _____ Combination Control	**B.** Temperature sensitive device used to control equipment response to the demands of the space in which they are located.
(3) _____ Fuel Pump	**C.** Safety device used to interrupt electrical power to the main gas valve.
(4) _____ Fan Control	**D.** Start and Stop the fan motor on an increase or decrease in temperature inside the furnace.
(5) _____ Heat Exchanger	**E.** Combines the limit control and fan control.
(6) _____ Blower Speed	**F.** Changes the temperature rise in a furnace.
(7) _____ Limit Control	**G.** Acts as the combustion area, the transfer medium, and flue passages.
(8) _____ Flame Detector Circuit	**H.** Determines whether or not a satisfactory flame has been established.
(9) _____ Orifices	**I.** Furnishes the combustion air to the flame.
(10) _____ Thermostat	**J.** Supplies fuel oil to the burner.
(11) _____ Burner	**K.** Atomizes the fuel.
(12) _____ Oil Burner Blower	**L.** Regulates the fuel flow to the burner.

TROUBLESHOOT

CORRECT MALFUNCATIONS

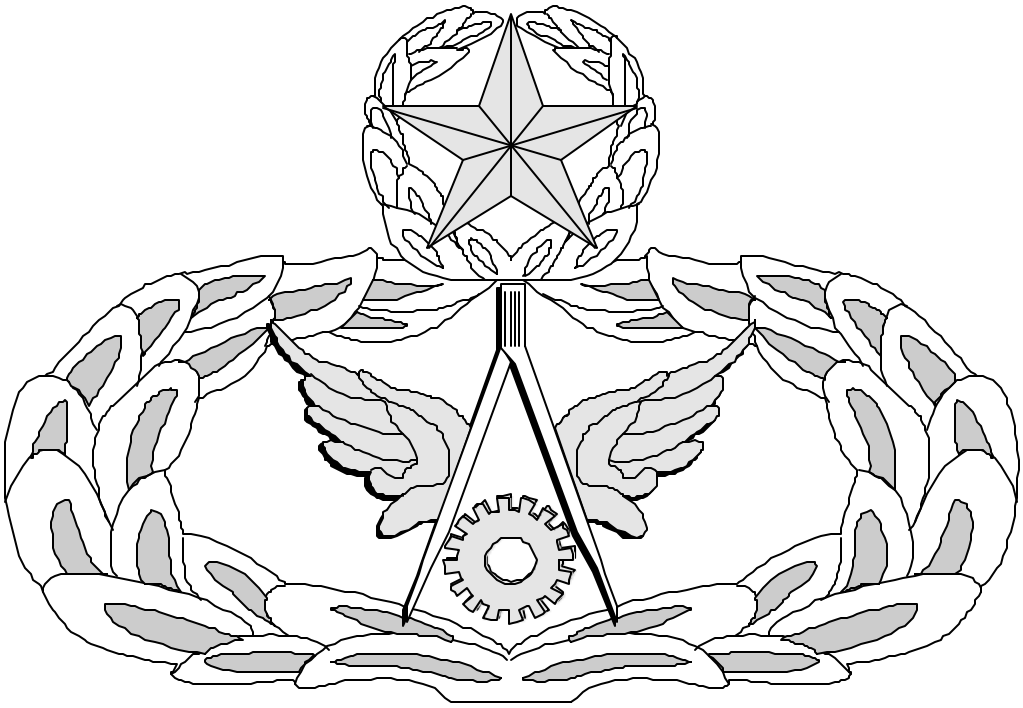
Performance Checklist		
Step	**Yes**	**No**
Troubleshoot & Correct Malfunctions:		
1. Bearings		
2. Burner		
3. Thermostat		
4. Limit Control		
5. Fan Control		
6. Combination Control		
7. Blower Speed		
8. Belts		
9. Sheaves		
10. Heat Exchanger		
11. Blower Assembly		
12. Flame Detector Circuit		
13. Oil Burner Blower Wheel		
14. Fuel Pump		
15. Nozzles		
16. Nozzle Filter		
17. Orifices		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

Air Force Civil Engineer

QUALIFICATION TRAINING PACKAGE (QTP)

REVIEW ANSWER KEY



For

HVAC/REFRIGERATION

(3E1X1)

MODULE 23

WARM AIR HEATING

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

Troubleshoot
(3E1X1-23.5.1.)

Correct Malfunctions
(3E1X1-23.5.2.)

Question	Answer
1. What causes flash back in a burner?	a. Distorted slots
2. Restricting the primary airflow on a burner will cause a yellow flame, which improves combustion.	b. False
3. An ideal flame is one that doesn't have a yellow tint, but is hard and blowing.	b. False
4. Of the following, which is an ideal place to locate a thermostat?	d. Interior Wall
5. How many degrees F. off calibration must a thermostat be before replacement is recommended?	d. 10
6. A limit control will shut off the main gas valve when the air temperature reaches about ____.	c. 93 degrees C.
7. Some key factors to take into consideration when replacing a limit control are the length and sensing element.	a. True
8. The purpose of the limit control is to ___.	a. Prevent overheating.
9. What causes cold drafts in a warm air heating system?	c. Exceeding minimum temperature rise in furnace.
10. What must always be checked after installing or readjusting V-belts?	b. Amperage
11. Belts being thrown from a sheave are a good indication of what problem?	c. Misaligned sheaves
12. The best method of repair to a cracked heat exchanger is to weld it.	b. False
13. How much time will elapse prior to the flame detector shutting down the oil burner if a satisfactory flame is not detected?	c. 1 minute
14. What will cause an oil burner blower wheel to bind up?	d. All of the above
15. If proper atomization is not being delivered and the pump is supplying the prescribed pressure, where is the problem?	a. Nozzles
16. How are orifices sized?	d. All of the above
17. Under firing is caused by _____.	a. Plugged nozzle filter

Troubleshoot
(3E1X1-23.5.1.)

Correct Malfunctions
(3E1X1-23.5.2.)

Instructions: Match the component in column A with its description in column B Items in column B are used only once.

COLUMN A	COLUMN B
(1) K Nozzles	**A.** A place for the mixing of fuel and air and to burn the mixture.
(2) E Combination Control	**B.** Temperature sensitive device used to control equipment response to the demands of the space in which they are located.
(3) J Fuel Pump	**C.** Safety device used to interrupt electrical power to the main gas valve.
(4) D Fan Control	**D.** Start and Stop the fan motor on an increase or decrease in temperature inside the furnace.
(5) G Heat Exchanger	**E.** Combines the limit control and fan control.
(6) F Blower Speed	**F.** Changes the temperature rise in a furnace.
(7) C Limit Control	**G.** Acts as the combustion area, the transfer medium, and flue passages.
(8) H Flame Detector Circuit	**H.** Determines whether or not a satisfactory flame has been established.
(9) L Orifices	**I.** Furnishes the combustion air to the flame.
(10) B Thermostat	**J.** Supplies fuel oil to the burner.
(11) A Burner	**K.** Atomizes the fuel.
(12) I Oil Burner Blower	**L.** Regulates the fuel flow to the burner.